

support substrate slightly separated to each other is used to place the piezoelectric substrate and the pair of drive electrodes on both sides thereof, it is not necessary to provide an independent space for storing the structure which generates the vibration.

[0034] A touch panel input device according to a third aspect of the invention is the touch panel input device according to the second aspect, characterized in that the pressure detecting means impresses a detecting voltage on, or detects a voltage of any leader electrode electrically connected with a peripheral edge of the individual conductor layer of the movable plate or the support substrate to detect the pressure and the pressed position on the input operation surface, the leader electrode fixed on the inner surface of the frame of the movable plate or the support substrate serves as one of the drive electrodes of the piezoelectric substrate, and the piezoelectric substrate is fixed through the leader electrode.

[0035] Because the leader electrode electrically connected with the peripheral edge of the conductor layer is shared by one of the drive electrodes of the piezoelectric substrate, it is not necessary to form one drive electrode independently.

[0036] Because the leader electrode is an electrode for electrically connecting the conductor layer with the outside, it is possible to use the leader electrode and wiring connected with the outside for impressing the drive voltage on the one of the drive electrodes.

[0037] A touch panel input device according to a fourth aspect of the invention is the touch panel input device according to the first aspect, characterized in that the piezoelectric substrate is fixed directly or through the drive electrode on a rear surface of the support substrate.

[0038] Because the piezoelectric substrate is simply fixed through the one of the drive electrodes on the rear side of the support substrate of the touch panel input device, the vibration feature is added without changing the conventional structure.

[0039] A touch panel input device according to a fifth aspect of the invention is the touch panel input device according to the fourth aspect, characterized in that the movable plate and the support substrate are made of a transparent material for transmitting emitted light from a light-emitting element for illumination provided on a rear side of the support substrate, and the piezoelectric substrate is fixed directly or through the drive electrode to a part of a rear surface of the support substrate where the leader electrodes electrically connected with the peripheral edge of the conductor layer are formed.

[0040] Because the piezoelectric substrate is fixed on the rear side of the support substrate between wiring for the light-emitting element and the leader electrodes, the leader electrodes are shielded by the drive electrodes fixed on both surfaces of the piezoelectric substrate opposing to each other, and a high frequency noise generated on the wiring for the light-emitting element is prevented from transmission to the leader electrodes as a result of static capacitive coupling.

[0041] A touch panel input device according to a sixth aspect of the invention is the touch panel input device according to any one of the first to fifth aspects, characterized in that an output voltage present on both ends of a coil

when a low voltage trigger pulse is supplied is impressed as a drive voltage on the pair of drive electrodes of the piezoelectric substrate when a pressure is detected on the input operation surface.

[0042] Because the movable plate or the support substrate itself vibrates with a large amplitude, simply impressing the drive voltage in a momentary pulse waveform present on both ends of the coil when a trigger pulse is entered on the piezoelectric substrate generates a vibration sensitive to an operator on the movable plate or the support substrate.

[0043] A touch panel input device according to a seventh aspect of the invention is the touch panel input device according to any one of the first to fifth aspects, characterized in that, when a pressure is detected on the input operation surface, a drive voltage with an audio band frequency is impressed on the pair of drive electrodes to contract and expand the piezoelectric substrate for vibrating the movable plate or the support substrate at the audio band frequency, and a sound representing an input operation is generated.

[0044] Because the movable plate or the support substrate vibrates at the audio band frequency, and generates an operation sound for representing a pressure detection, it is possible to use the operation sound to generate an input operation feeling without providing an independent speaker.

[0045] The above, and other objects, features and advantages of the present invention will become apparent from the following description read in conjunction with the accompanying drawings, in which like reference numerals designate the same elements.

BRIEF DESCRIPTION OF THE DRAWINGS

[0046] FIG. 1 is an exploded perspective view of a touch panel input device according to an embodiment of the present invention.

[0047] FIG. 2 is a longitudinal sectional view of a principal part of the touch panel input device of FIG. 1.

[0048] FIG. 3(a) is a descriptive drawing showing an installation of a piezoelectric substrate.

[0049] FIG. 3(b) is a perspective view of a principal part showing a connection between a pair of drive electrodes and leads.

[0050] FIG. 4 is a block diagram of a first drive circuit for driving the piezoelectric substrate of FIG. 1.

[0051] FIG. 5(a) shows a drive voltage waveform for generating a click feeling in the embodiment of FIG. 1.

[0052] FIG. 5(b) shows a drive voltage waveform for generating moderate vibration feeling in the embodiment of FIG. 1.

[0053] FIG. 5(c) shows a drive voltage waveform for generating an audible sound in the embodiment of FIG. 1.

[0054] FIG. 5(d) shows a drive voltage waveform for generating an audible sound after a click feeling in the embodiment of FIG. 1.

[0055] FIG. 6 is a block diagram of a second drive circuit for driving the piezoelectric substrate of FIG. 1.